WHAT IS CLAIMED IS:

1. A biofunctionalized quantum dot, comprising:

a nanocrystalline core exhibiting quantum confinement and having a band gap and a surface;

a mercaptoalkanoic acid linked to the surface; and,

a biofunctional group linked to the surface.

2. The biofunctionalized quantum dot of claim 1,

the ratio of mercaptoalkanoic acid molecules to biofunctional group molecules linked to the surface is in the range of from about 1:1 to about 5:1.

3. The biofunctionalized quantum dot of claim 1,

the mercaptoalkanoic acid not comprising mercaptosuccinic acid.

4. The biofunctionalized quantum dot of claim 1,

the mercaptoalkanoic acid having exactly one carboxyl group and comprising less than seven carbon atoms.

5. The biofunctionalized quantum dot of claim 1,

the mercaptoalkanoic acid comprising mercaptoacetic acid.

6. The biofunctionalized quantum dot of claim 1, further comprising:

a shell layer overcoating the nanocrystalline core.

7. The biofunctionalized quantum dot of claim 6,

the shell layer comprising cadmium sulfide and

the nanocrystalline core comprising cadmium telluride.

8. The biofunctionalized quantum dot of claim 6,

the shell layer comprising cadmium sulfide and

the nanocrystalline core comprising cadmium selenide.

9. The biofunctionalized quantum dot of claim 6,
the shell layer comprising mercury sulfide and
the nanocrystalline core comprising mercury telluride.

10. The biofunctionalized quantum dot of claim 6,
the shell layer comprising mercury sulfide and
the nanocrystalline core comprising mercury selenide.

11. The biofunctionalized quantum dot of claim 1,
the biofunctional group being a saccharide.

12. The biofunctionalized quantum dot of claim 11,
the saccharide not comprising mannose or dextran.

13. The biofunctionalized quantum dot of claim 11,
the saccharide being a tumor-associated carbohydrate antigen.

14. The biofunctionalized quantum dot of claim 11,
the saccharide being Thomsen-Friedenreich disaccharide.

15. The biofunctionalized quantum dot of claim 11,
the saccharide linked to a sulfur atom; and,
the sulfur atom linked to the surface of the nanocrystalline core.

16. The biofunctionalized quantum dot of claim 11,
the saccharide linked to a linking group;
the linking group linked to a sulfur atom; and,
the sulfur atom linked to the surface of the nanocrystalline core.

17. The biofunctionalized quantum dot of claim 16,
the linking group comprising a carbon atom.

18. The biofunctionalized quantum dot of claim 1,

the biofunctional group having a molecular weight greater than a molecular weight of the mercaptoalkanoic acid.

19. The biofunctionalized quantum dot of claim 1,

the biofunctional group having a molecular volume greater than a molecular volume of the mercaptoalkanoic acid.

20. A biofunctionalized quantum dot, comprising:

a nanocrystalline core exhibiting quantum confinement and having a surface; and,

a biofunctional group linked to the surface, wherein

the biofunctionalized quantum dot is stable in aqueous solution under storage in the dark at 4 °C for at least 4 months with respect to luminescence, precipitation, flocculation, and leaching of the biofunctional group.

21. A formulation comprising:

a liquid; and,

a biofunctionalized quantum dot, comprising

a nanocrystalline core exhibiting quantum confinement and having a surface,

a mercaptoalkanoic acid linked to the surface, and

a biofunctional group linked to the surface, wherein

the biofunctionalized quantum dot is dissolved or suspended in the liquid and

the biofunctionalized quantum dot does not precipitate or flocculate.

22. The formulation of claim 21,

the biofunctional group being a saccharide.

23. The formulation of claim 22,

the saccharide being Thomsen-Friedenreich disaccharide.

24. The formulation of claim 22,

the mercaptoalkanoic acid comprising mercaptoacetic acid.

25. A method for producing a biofunctionalized quantum dot, comprising the steps of:

providing a biofunctional group-thiol of Formula III; and,

III

refluxing the biofunctional group-thiol of Formula III with a cadmium salt, a hydrogen-alkali-group VIA element, and a suitable solvent to produce a quantum dot in a solution, wherein

R_1 comprises a carbon atom and

the group VIA element is selected from the group consisting of tellurium and selenium.

26. The method of claim 25,

the suitable solvent comprising water.

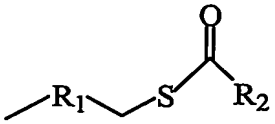
27. The method of claim 25,

the suitable solvent comprising N,N-dimethylformamide.

28. The method of claim 25, further comprising the steps of:

reacting a glycoside of Formula I with an alkylthio acid in the presence of a catalyst to produce a thioester of Formula II;

I

Acetylated, Benzylidenated Biofunctional Group 

II

debenzylidenating the thioester of Formula II; and,

hydrolyzing the thioester of Formula II to produce the biofunctional group-thiol of Formula III, wherein

R_1 comprises a carbon atom and R_2 comprises a carbon atom.

29. The method of claim 25,

the refluxing further comprising refluxing with a mercaptoalkanoic acid.

30. The method of claim 25, wherein

the biofunctional group is a saccharide.

31. The method of claim 30, wherein

the saccharide is Thomsen-Friedenreich disaccharide.

32. The method of claim 25, further comprising the steps of:

purifying the solution; and,

drying the purified solution to obtain a biofunctionalized quantum dot preparation.

33. The method of claim 32,

the purifying comprising separating the saccharide-functionalized quantum dot from the remainder of the solution by filtration through an ultrafiltration membrane with a cutoff of about 50 kilodaltons.

34. The method of claim 32, further comprising the step of:

dissolving or suspending the purified and dried biofunctionalized quantum dot preparation in an aqueous solvent.

35. The method of claim 29,

conducting the refluxing for from about 24 to about 48 hours.

36. The method of claim 29,

the mercaptoalkanoic acid being mercaptoacetic acid.

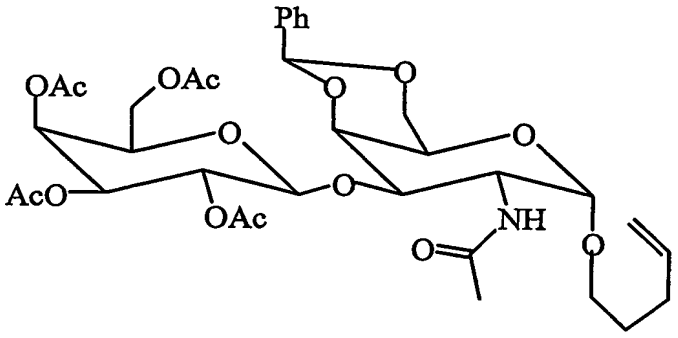
37. The method of claim 36,

the biofunctional group being Thomsen-Friedenreich disaccharide; and,

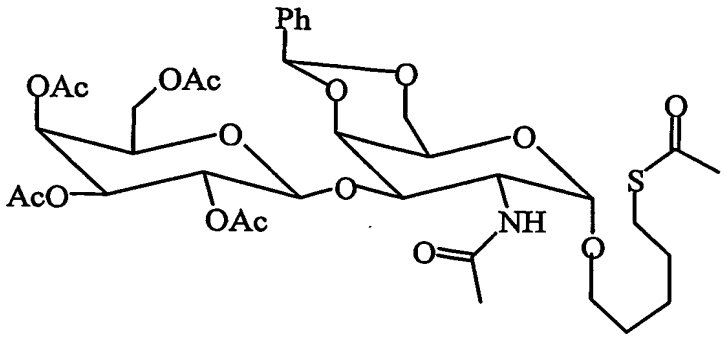
the mercaptoacetic acid and the Thomsen-Friedenreich-thiol being in a molar ratio of from about 1:1 to about 5:1.

38. A method for producing a biofunctionalized quantum dot, comprising the steps of:

reacting a glycoside of Formula IV with an alkylthio acid in the presence of 2,2'-azobisisobutyronitrile in 1,4-dioxane at about 75 °C to produce a thioester of Formula V;



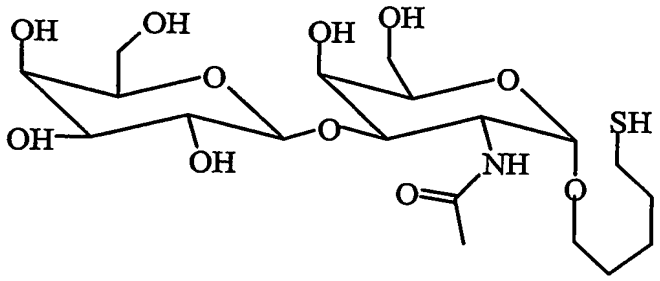
IV



V

debenzylidinating the thioester of Formula V;

hydrolyzing the debenzylidinated thioester of Formula V to produce a Thomsen-Friedenreich-thiol of Formula VI; and,



VI

refluxing the Thomsen-Friedenreich-thiol of Formula VI with cadmium perchlorate, mercaptoacetic acid, hydrogen sodium telluride, and a suitable solvent, selected from the group consisting of water and N,N-dimethylformamide, to produce a Thomsen-Friedenreich-functionalized quantum dot in a solution.

39. The method of claim 38,

the debenzylidinating comprising the steps of

treating the thioester of Formula V with aqueous acetic acid at about 60 °C and

evaporating to obtain debenzylidinated thioester.

40. The method of claim 38,

the debenzylidinating comprising the steps of

treating the thioester of Formula V with acetyl chloride in methanol,

adding pyridine to the thioester of Formula V with acetyl chloride in methanol for quenching the reaction, and

evaporating to obtain debenzylidinated thioester.

41. The method of claim 38,

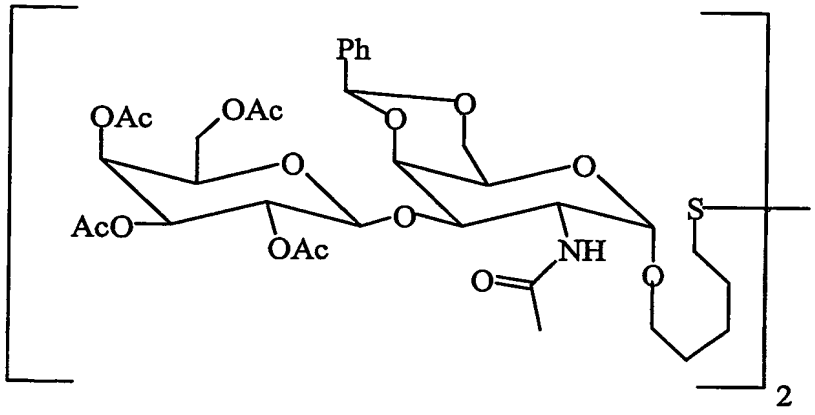
the hydrolyzing comprising the step of

treating the debenzylidinated thioester with sodium methoxide in methanol to produce the Thomsen-Friedenreich-thiol of Formula VI.

42. The method of claim 38,

the hydrolyzing comprising the steps of

treating the debenzylidinated thioester with sodium methoxide in methanol while bubbling air through the debenzylidinated thioester, sodium methoxide, and methanol to produce a Thomsen-Friedenreich-disulfide of Formula VII and



VII

treating the Thomsen-Friedenreich-disulfide of Formula VII with dithiothreitol in water to produce the Thomsen-Friedenreich-thiol of Formula VI.

43. A method of imaging, comprising the steps of:

providing a biofunctionalized quantum dot having a characteristic wavelength and comprising

a nanocrystalline core exhibiting quantum confinement having a surface, and

a biofunctional group linked to the surface;

contacting the biofunctionalized quantum dot with a biological material;

exposing the biological material to light having a wavelength effective to cause the quantum dot to fluoresce; and,

imaging the fluorescing quantum dots, wherein

said biofunctional group comprises a saccharide or the quantum dot further comprises a mercaptoalkanoic acid linked to the surface.

44. The method of claim 43, further comprising the step of

imaging the fluorescing quantum dot adhered to secretions of the biological material.

45. The method of claim 43,

the biofunctional group being Thomsen-Friedenreich disaccharide.

46. The method of claim 43, further comprising the step of

dissolving or suspending the biofunctionalized quantum dot in a biocompatible aqueous solvent.

47. The method of claim 43,

the biological material comprising a cell culture.

48. The method of claim 43,

the biological material comprising a tissue.

49. The method of claim 43,

the contacting comprising injecting the biofunctionalized quantum dot into tissues of a living animal.

50. The method of claim 43, further comprising the step of

using the imaging to identify tissue to which the biofunctional group exhibits high affinity as tissue in a diseased or abnormal state.

51. The method of claim 43,

the diseased or abnormal state being cancerous.

52. A method of medical imaging, comprising the steps of:

providing two types of biofunctionalized quantum dots, each type having a characteristic wavelength distinct from the other types, each quantum dot comprising

a nanocrystalline core exhibiting quantum confinement having a surface, and

a biofunctional group linked to the surface;

each type of quantum dot functionalized with a different antigen or a different set of antigens;

contacting the two types of biofunctionalized quantum dots with a biological material;

exposing the biological material to light having a wavelength effective to cause the quantum dots to fluoresce; and,

imaging the fluorescing quantum dots, wherein

said biofunctional group comprises a saccharide or the quantum dot further comprises a mercaptoalkanoic acid linked to the surface.

53. A method of therapy, comprising the steps of:

providing a biofunctionalized quantum dot having a characteristic wavelength and comprising

a nanocrystalline core exhibiting quantum confinement having a surface and

a biofunctional group linked to the surface; and,

contacting the biofunctionalized quantum dot with a biological material and thereby treating a disease, wherein

said biofunctional group comprises a saccharide or the quantum dot further

comprises a mercaptoalkanoic acid linked to the surface.

54. The method of claim 53, further comprising

exposing the biological material to light having a wavelength effective to cause the quantum dots to fluoresce; and,

imaging the fluorescing quantum dots.

55. The method of claim 53,

the biofunctional group being an immune-response stimulating group.

56. The method of claim 53,

the biofunctional group being a tumor-associated antigen.

57. The method of claim 53,

the biofunctional group being Thomsen-Friedenreich disaccharide.

58. The method of claim 53, further comprising the step of

dissolving or suspending the biofunctionalized quantum dot in a biocompatible aqueous solvent.

59. The method of claim 53,

the contacting comprising injecting the biofunctionalized quantum dot into tissues of a living animal.

60. The method of claim 53, wherein

the disease is cancer.

61. The method of claim 53, wherein

the quantum dot further comprises a therapeutic agent linked to the surface.

62. The method of claim 53, wherein

a shell layer or the nanocrystalline shell comprises a therapeutic agent.

63. A biofunctionalized quantum dot coated device, comprising

a device adapted for contact with a biological material and having a device surface;

biofunctionalized quantum dots comprising

a nanocrystalline core exhibiting quantum confinement having a surface and

a biofunctional group linked to the surface; and,

the biofunctionalized quantum dots linked to the device surface to form a coating on the device, wherein

said biofunctional group comprises a saccharide or the quantum dot further comprises a mercaptoalkanoic acid linked to the surface

64. A cell-quantum dot complex, comprising:

a biofunctionalized quantum dot comprising

a nanocrystalline core exhibiting quantum confinement having a surface and

a biofunctional group linked to the surface; and,

a cell, wherein

the biofunctional group is linked to the cell and

said biofunctional group comprises a saccharide or the quantum dot further comprises a mercaptoalkanoic acid linked to the surface.

65. The complex of claim 64, wherein

the biofunctionalized quantum dot further comprises a mercaptoalkanoic acid linked to the surface.

66. The complex of claim 64,

the biofunctional group being Thomsen-Friedenreich disaccharide.